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THERMAL BLOCK FOR HEAT EXCHANGER TUBE SHEET

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FIG. 1

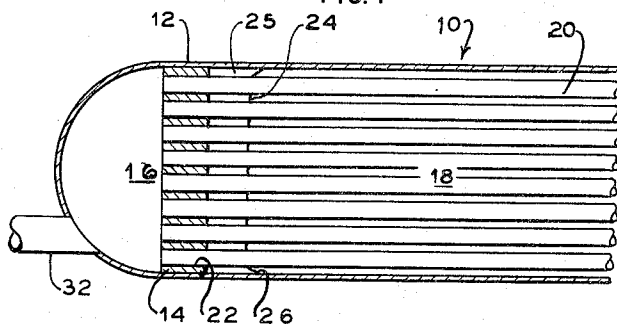


FIG. 2

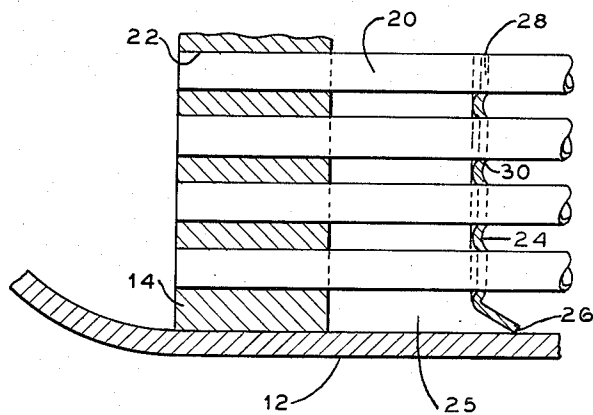
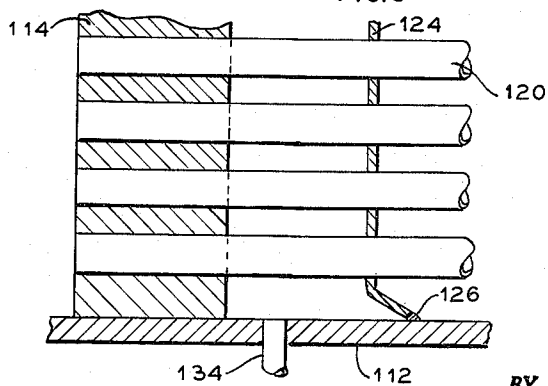


FIG. 3



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THERMAL BLOCK FOR HEAT EXCHANGER TUBE SHEET

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This invention relates to heat exchangers of the type employing tube sheets and more particularly, it is concerned with a thermal block or insulator for the tube sheet of such heat exchangers.

In heat exchangers the difference in temperature or the thermal gradient between the hot fluid and the cold fluid causes thermal stressing of the various components which separate the fluids. Thermal gradients do not generally result in any damage to thin walled components such as tubes because the difference in temperature is relatively small across the tube wall. However, in thick walled structures, such as tube sheets, the temperature differences and, as a result, the thermal stresses are both much greater. Due to the strains which result from the thermal stresses, cracks may develop in the tube sheet or in the connections between the tube sheet and the heat exchanger shell or tube. In turn leakage through such cracks may result in accelerated corrosion or in violent chemical reactions depending upon the characteristics of the heat exchange fluid.

In attempting to solve this problem in the past it has been known to use thermal blocks on the tube side of the tube sheet to reduce the thermal gradient across the tube sheet. However, the thermal blocks used in the past have been quite large and, therefore, both costly and difficult to assemble within the heat exchanger.

It is the primary object of the present invention to provide an arrangement for reducing the thermal gradient across a tube sheet which is simple in construction, inexpensive and relatively easy to assemble within a heat exchanger.

Therefore, the present invention provides a thermal block comprising a relatively thin sheet of metal plate spaced from the tube sheet which provides a layer of static or quiescent fluid separating the tube sheet from the fluid flowing over the tubes within the heat exchanger.

The various features of novelty which characterize this invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

Of the drawings:

FIG. 1 is a partial longitudinal sectional view of a heat exchanger embodying the present invention;

FIG. 2 is a considerably enlarged detail illustrating the arrangement of the tubes, tube sheet and thermal block of FIG. 1; and

FIG. 3 is another embodiment of the arrangement shown in FIG. 2.

In the drawings similar elements are identified by the same reference numeral with the addition in FIGURE 3 of a prefix numeral.

In FIG. 1 there is shown a heat exchanger 10 of the type well known in the art and often characterized as a shell and tube heat exchanger. The opposite end of such heat exchangers may be similarly constructed to that shown in FIG. 1 so that the tubes extend between a pair of tube sheets. Another heat exchanger of this general type employs U-shaped tubes, as shown in U.S. Patent No. 2,910,275, with a partition dividing the supply cham-

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ber at the left end of FIG. 1 to act both as an inlet and outlet space. Still another heat exchanger of this general type employs double tube sheets and double or field tubes, as shown in U.S. Patent No. 3,090,433. The field tube is a double tube arrangement with the inner tube spaced inwardly from the outer tube forming an annular passageway therebetween. At its end opposite the tube sheet the outer tube is closed while the corresponding end of the inner tube is open. In this way a fluid can flow serially through the annular passageway and the interior of the inner tube, with the direction of flow being determined by the factors affecting the individual embodiment. In combination with a shell the double tube sheet arrangement forms a pair of chambers which act as inlet and outlet spaces for the field tube arrangement. While the invention is illustrated and described as applying to a simple tube and shell heat exchanger, it will be readily apparent that it may be employed in any of the variations of this general type of heat exchanger.

In FIG. 1 the heat exchanger 10 comprises a closed ended cylindrically shaped shell 12 divided by a tube sheet 14 into a supply chamber 16 and a heat exchange chamber 18. A number of tubes 20 are connected into tube openings 22 in the tube sheet and extend longitudinally of the shell 12.

Within the heat exchange chamber 18 a thin metal plate 24 is spaced closely from the tube sheet 14 forming a chamber 25 therebetween. As shown in FIG. 2 the metal plate 24, as compared to the tube sheet, is relatively very thin. The entire peripheral edge 26 of the plate 24 is bent uniformly out of the plane of the plate away from the tube sheet 14 and bears against the inner wall of the shell 12. Due to its bent or flared construction, the edge of the plate forms a spring-like seal with the inner wall of the shell. Additionally, openings 28 are formed in the plate 24 to receive the tubes 20. These tube openings 28 may be punched out so that they provide a flared arrangement 30 somewhat similar in appearance to that of the peripheral edges 26. In such a construction the edges of the tube opening 28 are in closely fitting relationship with the tubes 20 holding them in a spring fit. However, the openings 28 permit a small amount of leakage through the openings 28 in the plate 24 generally from the heat exchange chamber 18 into the chamber 25.

Opening to the supply chamber 16 is a duct 32 which may be used to either introduce or remove fluid from the chamber. Though not shown in the drawings, an inlet and outlet are provided in the shell to pass a heat exchange fluid over the tubes 20. In the embodiment illustrated in FIGS. 1 and 2 the openings between the plate 24 and the tubes 20 would permit passage of the heat exchange fluid flowing over the tubes into the chamber 25.

In the embodiment presented in FIG. 3 a separate source of fluid other than that flowing over the tubes is introduced into the chamber 125 between the plate 124 and the tube sheet 114. Because of certain characteristics of the heat exchange fluids, it may be preferable to integrally secure the plate 124 to shell 112 and the tubes 120 so that no leakage is admitted in the chamber 125. The tubes 120 may be secured within the openings 128 in the plate 124 by rolling them into fluid-tight engagement with the plate. Further, the plate may be integrally secured to the shell about its peripheral edge 126, such as by brazing or welding.

In operation one of the heat exchange fluids would flow through the tubes 20 entering or leaving by means of the chamber 16. The other fluid would enter the heat exchange chamber 18 by inlet means (not shown) flow over the tubes within the heat exchange chamber 18 and then out through an outlet (not shown). A certain

amount of the fluid flowing over the tubes would find its way through the tube openings 28 into the chamber 25 between the plate and the tube sheet. In the chamber 25 the fluid provides a relatively quiescent zone between the heat exchange chamber 18 and the supply chamber 16. With this quiescent zone separating the plate 24 and the tube sheet 14, the thermal gradients across both, and particularly across the tube sheet, will be considerably reduced so that the possibility of any cracks developing in the tube sheet or in the connections between the tube sheet and shell or tubes is unlikely. Further, the flared arrangement of the plate 24 about its peripheral edge 26 and about the tube openings 28 provides a thermal sleeve-like arrangement which also tends to reduce the likelihood of any failures resulting from thermal stressing at these locations.

While in the embodiment shown in FIG. 1 the heat exchange fluid flowing over the tubes also acts as the separating fluid between the tube sheet and the plate 24, in FIG. 3 a separate source of fluid is supplied to chamber 125 through inlet 134.

Therefore, in the present invention the thin metal plate fitting over the tubes and in sealing relationship with the wall of the shell provide a simple yet effective thermal block between the plate and the tube sheet to prevent the development of excessive thermal stresses in the tube sheet.

As pointed out previously, this invention has been described and illustrated in a simple construction, however, it will be apparent to those skilled in the art that it may be applied to many different heat exchanger arrangements where the problem of thermal stressing of the various elements of the heat exchanger must be avoided.

While in accordance with the provisions of the statutes the invention has been illustrated and described in the best form and mode of operation of the invention now known, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. The combination forming a heat exchanger including a closed shell, a tube sheet disposed within and connected about its periphery to said shell and dividing the interior of the shell into a tube side and a chamber side, a plurality of tubes disposed within said shell on the tube side of said tube sheet and the ends of said tubes being fitted into said tube sheet, the improvement comprising:
 - (A) a metal plate very thin in comparison with said tube sheet positioned within said shell on the tube side of said tube sheet,
 - (B) said plate closely spaced from said tube sheet and forming a chamber comprising a narrow open space located between said tube sheet and plate and exteriorly of the tubes extending therebetween,

- (C) said tubes passing through and in closely fitting contacting relationship with said metal plate forming a pervious joint therebetween, and,
 - (D) the peripheral edge of said metal plate arranged in contact with the inner wall of said shell about its entire periphery for securing the plate in position within the shell whereby a relatively quiescent fluid zone is set up in the open space of said chamber between said metal plate and tube sheet.
2. The combination forming a heat exchanger including a closed shell, a tube sheet disposed within and connected about its periphery to said shell and dividing the interior of the shell into a tube side and a chamber side, a plurality of tubes disposed within said shell on the tube side of said tube sheet and the ends of said tubes being fitted into said tube sheet, the improvement comprising:
 - (A) a metal plate very thin in comparison with said tube sheet positioned within said shell on the tube side of said tube sheet,
 - (B) said plate arranged in substantially parallel relationship with and closely spaced from said tube sheet and forming a chamber comprising a narrow open space located between said tube sheet and plate and exteriorly of the tubes extending therebetween,
 - (C) said tubes passing through and in closely fitting contacting relationship with said metal plate forming a pervious joint therebetween, and,
 - (D) the peripheral edge of said metal plate bent uniformly out of the plane of the plate and in contact with the inner wall of said shell about its entire periphery whereby the peripheral edge of said metal plate provides a spring seal between said plate and shell for securing the plate in position within the shell, and whereby the open space of said chamber forms a relatively quiescent fluid zone between said metal plate and tube sheet.
 3. A heat exchanger as set forth in claim 2 wherein openings are formed in said metal plate for said tubes whereby the edges of the openings are flared away from the adjacent tube sheet providing a thermal sleeve-like arrangement at each of said openings.

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